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DISTRIBUTION, HABITAT REQUIREMENTS AND CONSERVATION OF *MACROMIA SPLENDENS* PICTET (ODONATA: CORDULIIDAE) IN GALICIA (NW SPAIN)

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Abstract

The range of *Macromia splendens*, a rare anisopteran, includes SE France and some scattered localities on the Iberian Peninsula. During 1996-1998, I made an exhaustive search for the characteristics of the species' larval and adult habitat, flight period and adult activity in NW Spain. Nine populations were found, greatly increasing its known range. Adults were observed on slowly flowing rivers, with deep, warm water. Seven populations were found on natural rivers, but two inhabited man-made hydroelectric reservoirs, where aquatic and riverine vegetation are absent. One population was found inside a Natural Park. Populations concentrated in zones with a mean annual temperature higher than 13°C. Larvae live among tree roots or flattened on the muddy substrate and emerge in May-June from eggs laid in June-July two years earlier. Pollution and habitat destruction are the main problems for the conservation of this species.

Introduction

Dragonflies are rarely considered in conservation measures. One of the reasons for this lack of interest is that many insect species are so common and widespread that it is difficult to believe that they are in danger. *Macromia splendens* Pictet (Corduliidae) is one exception to this rule (Dumont 1971). This big insect (7 cm body length) has all the characteristics of a rare species: it is only known from SE France and few localities in Spain and Portugal (Dommanget & Grand 1996). It breeds in a rare habitat: lentic areas of small to medium-sized rivers (giving the impression of a lake rather than a river, Bilek 1969) with sandy or muddy substrate, up to 250-300 m a.s.l. (Lieftinck 1965; Tiberghien 1985). Morton (1925) needed several years to find the species, and similar difficulties were experienced by Lieftinck (1965), although Belle (1983) found it to be common at the river Tarn in 1982.

Macromia splendens is the only European representative of a speciose genus common in tropical regions, and represents a remnant of a richer Late Pleistocene fauna that became extinct during glaciations (Lieftinck 1965). There are 112 species of *Macromia*: 50 in tropical Asia, 40 in tropical Africa, 10 in North America and 7 in Australia (Davis & Tobin 1985). This species was therefore included in Annex II of the Bern Convention as "strictly protected", and in Annex II of the Habitats Directive 92/43 (21-5-92) as a species whose conservation requires the designation of special areas of conservation.

Nevertheless, the status of *M. splendens* is poorly known, specially in the Iberian Peninsula. Published biological information on this species is based on French populations, because in Spain and Portugal there were only four known localities in the 1920s and one in the 1980s (Navás 1924; Seabra 1937, 1942; Ferreras Romero 1983).

In June 1995 I found some specimens flying near an artificial reservoir in northwestern Spain, far from published localities (Cordero 1996). This surprising finding started a search for the species in the area, and a study of its status and habitat requirements. My aims were to learn the characteristics of its larval and adult habitat, its flight period and activity.

Methods

Observations started in 1996 and continued during 1997, 1998 and only occasionally in 1999. Rivers were visited after selecting them from 1:25,000 maps. Once at the river I searched for suitable lentic areas, where I recorded all species of dragonflies seen. For a correct identification, I tried to collect a single male *M. splendens* at all localities where it was observed. I also searched the shore bank for exuviae, because this is proof of breeding. In 1997 I measured water temperature, pH, conductivity and oxygen concentration, and estimated water current using a floating leaf or cork.

In 1996 I made preliminary searches on nine rivers, and confirmed the presence of the species on four of them. I increased my sampling effort in 1997, visiting 18 rivers from 1 May to 30 July, covering 6 752 km in 41 days. In May 1997, I searched for larvae in four rivers, using standard hand nets. In 1998 I searched 11 rivers (only one not searched in 1997) from 24 May to 29 July, travelling 2 748 km in 29 days, concentrating on a mark-recapture study of one population, whose results are presented elsewhere (Cordero et al. 1999). A list of all localities is given in the Appendix.

Results

Figure 1 shows the localities where *M. splendens* has been found. These include nine rivers (Tambre, Deza, Lérez, Tea, Avia, Cabe, Miño, Arnoia and Limia, see Appendix for more information). Two of these populations were found in hydroelectric reservoirs (Albarellos reservoir on the river Avia and Lindoso reservoir on the river Limia). All populations were observed across two-three years, with the exception of that of the river Tambre, based on one fragment of one exuvia found in 1996, and the

population at the river Arnoia, based on sightings in 1997. Adults were collected at all rivers except Tambre, Miño and Arnoia. Exuviae were found at all rivers except Deza, Miño and Arnoia.

Figure 1 reveals a remarkable agreement between the distribution of *M. splendens* and mean annual temperature. It inhabits areas with mean annual temperature over 13°C, and therefore is restricted to places where winter temperature is high (Dommanget & Grand 1996). Population 7 (Tambre) is outside this range, but only one exuvia was found there, suggesting a marginal population, while the population at Albarellos (locality 16) is in a specially thermic valley. *M. splendens* seems absent from the north coast, probably due to the lack of slow waters. Most rivers in this thermic area have no lentic areas and some are in cold topoclimates, suggesting that the species is unable to survive there. Nevertheless, at six additional rivers (Xallas, Ulla, Umia, Verdugo, Ferreira, Tâmega) I made sightings of adult dragonflies that could be *M. splendens*, but in no case more than one specimen, which could mean wandering animals.

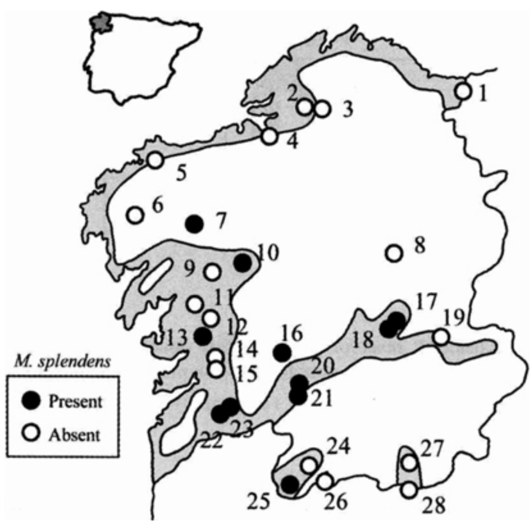


Figure 1. Map of Galicia (NW Spain) showing the approximate location of sampled rivers (designated by numbers). Shaded area has a mean annual temperature higher than 13°C (from Carballeira et al. 1983).

The population at Albarellos, first found in 1995 (Cordero, 1996) occupies an atypical habitat, a man-made reservoir. *M. splendens* is common here: adults have been observed every year from 1995 to 1999, and exuviae found at three different places in 1995, 1997, 1998 and 1999 (Fig. 2). These findings indicate that *M. splendens* has colonised the whole reservoir, formed by the river Avia and two tributaries, Cardelle and Valdeiras. This place also has the only populations of *Onychogomphus forcipatus* (Linnaeus) and *Gomphus graslini* Rambur of NW Spain. The last species is usually found together with *M. splendens* in France (Dommanget & Grand 1996). I searched seven more reservoirs but only found a population at Lindoso (loc. 25). Fig. 3 shows

the habitat of *M. splendens* at Albarellos. Note the dramatic change in water level between years. *M. splendens* seems to colonise only deep, elongated reservoirs with a clear similarity to rivers. It is able to survive in places without riverine vegetation.

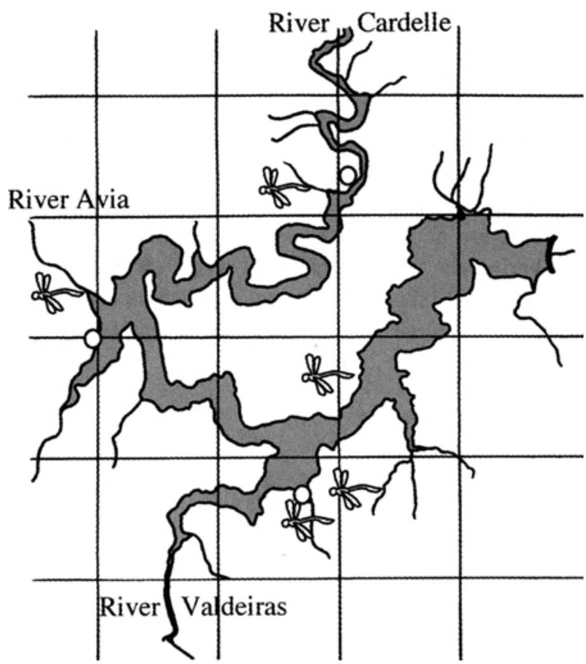


Figure 2. Map of the hydroelectric reservoir of Albarellos (locality 16 in Fig. 1), where *M. splendens* has its biggest population in NW Spain. Open circles indicate places where exuviae have been found, and dragonflies places where adults have been observed. 1 x 1 km UTM (Universal Transverse Mercator) grid.

Table 1 presents physical-chemical variables at places with and without *M. splendens*. Adult males have been observed flying in lentic areas of rivers (0.05 to 0.34 m/s^{-1}), with sand, stones or even mud substrates and a minimum of 1.5 m of depth. There were no significant differences in water temperature, pH, conductivity, or oxygen concentration ($p > 0.05$) between rivers with *M. splendens* and others without it.

Table 1. Physical-chemical variables (mean±SE) of sampled localities. No significant differences were detected between rivers with or without *Macromia* populations (t-tests, $p > 0.05$).

Presence of *M. splendens*	% O_2	O_2 ($mg \cdot l^{-1}$)	Temperature (°C)	Conductivity ($\mu S \cdot cm^{-1}$)	pH
Yes (n = 7)	97.4±1.69	8.99±0.117	17.7±0.50	70.1±17.48	7.26±0.152
No (n = 17)	95.9±6.84	10.08±0.689	18.4±1.85	78.5±11.48	7.09±0.217

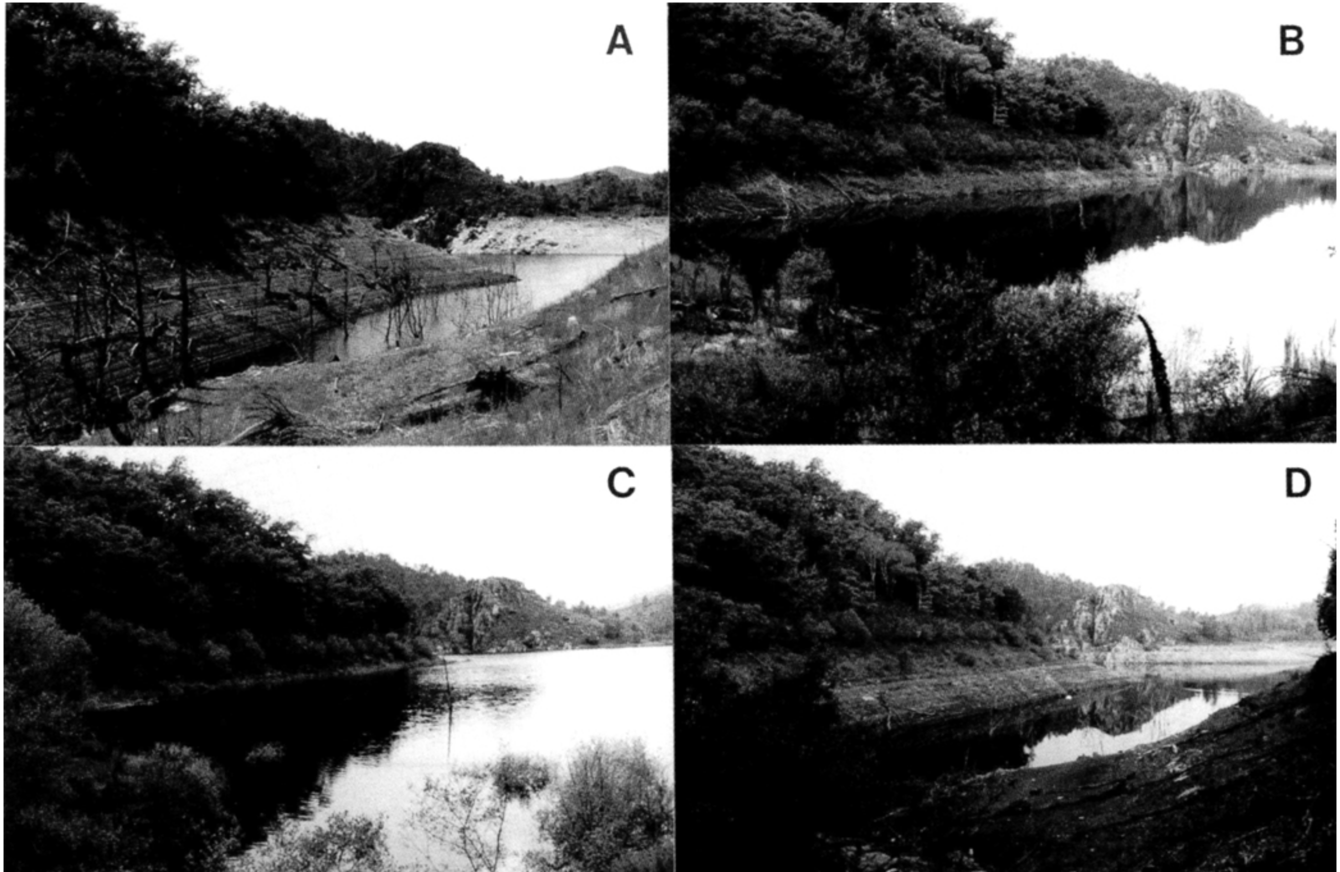


Figure 3. The habitat of *Macromia splendens* at the reservoir of Albarellos in four consecutive years. A, 11 June 1995. B, 8 June 1996. C, 8 June 1997 and D, 24 May 1998. *M. splendens* has been observed every year, even with extreme changes in water level.

Discussion

The rarity of M. splendens

Macromia splendens is a rare species. In Southeastern France, published accounts indicate that finding adults is difficult (Morton 1925; Lieftinck 1965). Bilek (1969) indicates that it is poorly known because it is difficult to detect but it can be locally common. A similar opinion is presented by Belle (1983). On the Iberian Peninsula, it was first cited by Navás (1924) from "Poigres" (apparently "Poiares" near Coimbra in Portugal, see Dommanget (1996) and from Segorbe, in Eastern Spain, a locality never confirmed. Seabra (1937, 1942) found it near Coimbra in 1922. The species was not recorded again until Ferreras-Romero (1983) collected a larva in the river Tavizna in 1981 (Cádiz, Southern Spain). In recent years it has been collected in several places of Spain and Portugal, suggesting the existence of more populations than previously thought (Benítez & García 1989; Ferreras-Romero & García Rojas 1995; Chelmick & Mitchell 1996; Jödicke 1996; Malkmus 1996; Cordero 1996; F.J. Ocharán pers. comm. 1997; J. Cabezas Flores pers. comm. 1998; Agüero-Pelegrín et al. 1998). Fig. 4 presents all known localities. This map suggests that *M. splendens* has a disjunct distribution, but with large populations in Southern France and Western Iberia. It is likely that the species will be found on most suitable rivers in Portugal, but there are no odonatologists in that country. It will also probably be found in many more places of southwestern Spain. We can therefore be confident as to the future of this species. It has more populations than previously thought.

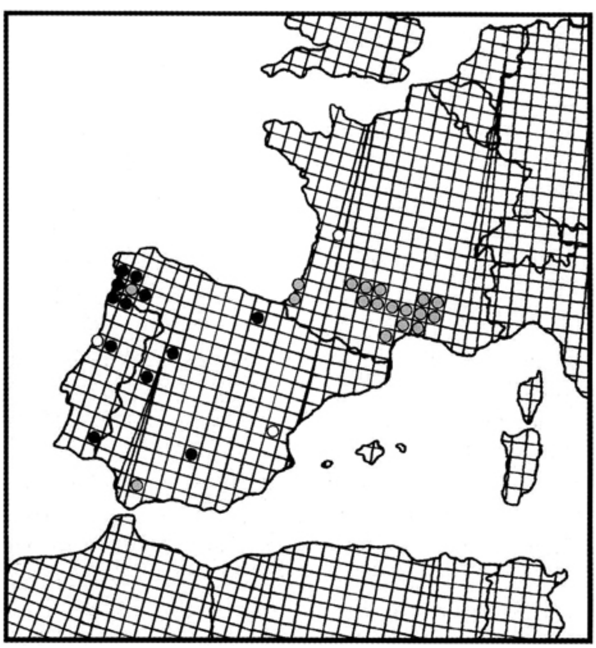


Figure 4. The world distribution of *Macromia splendens*. Open circles indicate old records (before 1950); grey circles localities included in Dommanget & Grand (1996); and black circles new records.

Habitat requirements

The main factor that seems to limit the distribution of *M. splendens* is temperature (Dommanget & Grand 1996): it is invariably found in mild climates, breeding in slowly flowing rivers, with abundant vegetation. Some authors mention that places where the species flies are rather innacessible (Lieftinck 1965; Bilek 1969) and I have the same impression from NW Spain. Almost all populations occur at low-altitude rivers (up to 250-300 m; Lieftinck 1965; Tiberghien 1985), but one population was found at 620 m (Dommanget & Grand 1996) and a single larva at 640 m (J. Cabezas Flores pers. comm. 1998). Water is commonly very deep in areas of river bank patrolled by adult males (from 1.5 to 4 m in NW Spain, and even more in reservoirs), but small populations can also be found on shallow, rapid waters (Dommanget & Grand 1996; Schütte & Suhling 1997).

Dommanget & Grand (1996) indicate that hydro-electric dams may provide a substitute habitat for *M. splendens* in southern France, by forming large waterbodies similar to the natural habitat. Small weirs constructed for old water-mills also provide suitable lentic areas. My observations in NW Spain revealed the biggest population to be situated on a man-made reservoir (Albarellos, Fig. 2). However, most reservoirs are not suitable for the species. Only elongated, deep reservoirs, that have a similarity to rivers are eligible. It is of interest to note that such places have no aquatic vegetation (Fig. 3), but this seems not to be a problem for the maintenance of the species (Cordero et al. 1999).

M. splendens seems rather tolerant to water chemistry. In NW Spain it inhabits acid waters (typical for rivers in this area, Membiela et al. 1991), but it has also been found in alkaline-water rivers (Grand 1996).

Larvae are said to live half-buried in muddy bottom (Grassé 1930; Aguesse 1968; Dommanget & Grand 1996). I think that the typical habitat is in fact tree roots, although some may live under leaf debris (Leipelt et al. 1999). My opinion is based on the direct observation of one larva on tree roots, and the finding of three more larvae in this microhabitat (two of them only 5.8 mm body length), and none on the bottom of the river (Cordero et al. 1999). Tree roots also are the typical habitat of other *Macromia* species (Wilson 1995). Nevertheless this species is able to successfully breed in artificial reservoirs, where riverine vegetation is totally absent (Fig. 3), suggesting that larvae can also live as shallow burrowers, as Lieftinck (1965) supposed. How they mitigate fish predation in such habitats remains unknown. Recent work by Leipelt et al. (1999) indicate that larvae prefer leaf detritus on sand rather than bare sand or stones, probably as an antipredation strategy. They found that larvae are able to burrow out of sight in 5-18.5 min.

Lieftinck (1965) suggested a three-year larval stage, and Dommanget & Grand (1996) indicate that larval development takes 22-23 months (starting July/August in year 1 up to May/June in year 3; see also Cordero et al. 1999). Unfortunately, no larval sampling study has yet established the life cycle in the field. Adults are on the wing from the second half of May to the end of July, a flight period slightly shorter than in France (Dommanget & Grand 1996).

Conservation

From the above results I conclude that *M. splendens* is widespread in NW Spain. It has good populations in seven rivers and at least two man-made reservoirs. There is no danger of extinction in the short-term.

Lieftinck (1965) and Belle (1983) indicated that adult collecting is not a real danger for the species, but Tiberghien (1985) and Grand (1988) recomend not to collect the species if not absolutely necessary. In my opinion the species is self-protected because it flies in innaccessible areas and is difficult to capture, making over-collection highly unlikely. In any case, the species is protected by law in Spain and a permit is needed to collect it.

The real problem for the conservation of the species are habitat destruction and water pollution. Belle (1983), van Tol & Verdonk (1988) and Dommanget (1995) called hydro-electric dams a problem for *M. splendens* conservation. Even if the species breeds in some man-made reservoirs, this kind of habitat will usually be negative. Only elongated reservoirs provide an adequate habitat for *M. splendens* larvae. Water pollution seems also important. All sites where the species lives in NW Spain have non-polluted water. Most populations live far from human settlements. It is interesting to note that the only big river without *M. splendens* inside its best geographical area is the Umia (loc. 11). It has many suitable areas, but is polluted by urban sewage.

The only population of *M. splendens* in NW Spain that is protected inhabits the Lindoso reservoir (loc. 25) which is part of the Xurés Natural Park. There seems to be no real danger for the species in the near future.

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Appendix

List of sampled localities. Numbers refer to Fig. 1. All U.T.M. coordinates start by 29T.

	River	Locality	Council and province	UTM	Altitude (m)	*M. splendens*	Latitude	Longitude
1	Eo	Peigar	Trabada, Lugo	PJ5310	20	No	43°26'	7°04'
2	Eume	Caaveiro	Fene, A Coruña	NJ7507	40	No	43°25'	8°04'
3	Eume (reservoir)	O Xen	Monfero, A Coruña	NJ8603	330	No	43°23'	8°01'
4	Mandeo	Chelo	Paderne, A Coruña	NH6790	20	No	43°16'	8°08'
5	Anllóns	Ponte Anllóns	Ponteceso, A Coruña	NH0987	50	No	43°14'	9°24'
6	Xallas	Ponte Olveira, Brandomil	Mazaricos, A Coruña	NH0762	300	No	43°00'	8°54'
7	Tambre	Bouza	Santiago de Compostela, A Coruña	NH3257	180	Yes	42°58'	8°35'
8	Ferreira	Ourol	Portomarín, Lugo	PH1246	265	No	42°46'	7°35'
9	Ulla	Arnois, Pontevea	A Estrada, Pontevedra	NH4834	50	No	42°47'	8°23'
10	Deza	Zanca, Souto	Carbia, Pontevedra	NH5436	70	Yes	42°46'	8°20'
11	Umia	Poño Louro	Caldas de Reis, Pontevedra	NH2816	20	No	42°36'	8°34'
12	Rons (Pontillón de Castro reservoir)	Campozales	Pontevedra, Pontevedra	NH3105	180	No	42°30'	8°37'
13	Lérez	Castiñeira	Tenorio, Cotobade, Pontevedra	NH3500	20	Yes	42°28'	8°35'
14	Verdugo	O Corneiro, Pozos da Freixa	Pontecaldelas, Pontevedra	NG4293	270	No	42°22'	8°27'
15	Oitavén (Eiras reservoir)	Oitavén	Fornelos de Montes, Pontevedra	NG4287	240	No	42°20'	8°30'
16	Avia (Albarellos reservoir)	Airiz, Mourelle, Campo da Roda	Avión, Ourense	NG6492	270	Yes	42°23'	8°12'
17	Cabe	Areas	Pantón, Lugo	PH1201	240	Yes	42°28'	7°38'
18	Cabe	Valdeantes	Pantón, Lugo	PH0998	140	Yes	42°27'	7°39'
19	Lor	Freixeiro	Quiroga, Lugo	PH3604	260	No	42°28'	7°21'
20	Miño	A Barca	Arnoia, Ourense	NG7081	70	Yes	42°14'	8°10'
21	Arnoia	Coto do Outeiriño dos Cans	Arnoia, Ourense	NG7275	110	Yes	42°12'	8°06'
22	Tea	O Caneiro	Ponteareas, Pontevedra	NG4074	30	Yes	42°13'	8°30'
23	Tea	Mondariz-Balneario	Mondariz-Balneario, Pontevedra	NG4375	40	Yes	42°13'	8°29'
24	Limia	Lobios, Güín	A Porqueira, Bande, Ourense	NG8951	550	No	41°59'	7°56'
25	Limia (Lindoso reservoir)	Os Areeiros	Lobios, Ourense	NG7742	320	Yes	41°54'	8°04'
26	Salas (Salas reservoir)	Campelos	Muiños, Ourense	NG8742	840	No	41°55'	7°56'
27	Támega	Rabal	Oímbra, Ourense	PG2934	370	No	41°50'	7°26'
28	Támega	Laza	Laza, Ourense	PG2757	460	No	42°03'	7°28'

[1] UTM Universal Transverse Mercator.